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COMPARISON OF VENTILATION AND ICING SERVICES FOR EARLY CROP SEED POTATOES, NORTH DAKOTA TO FLORIDA, SEPTEMBER 1953 1/

A rather brisk movement of seed potatoes to Florida from the Red River Valley of North Dakota and Minnesota takes place during the latter part of August and the early part of September. These seed potatoes are intended for the early crop grown in southern Florida and are usually planted a short time after arrival. Normally the potatoes can be shipped satisfactorily by rail under standard ventilation. During periods of unseasonably warm weather, however, shippers have experienced rather serious transit losses from decay in these early crop seed potatoes moving to points in southern Florida under standard ventilation.

At the request of shippers and railroad representatives a series of transportation tests was conducted to compare several types of ventilation and refrigeration services for the protection of early crop seed potatoes during movement to southern Florida.

EXPERIMENTAL EQUIPMENT AND PROCEDURE

Ten carloads of potatoes were used in these tests, 4 for comparison of standard and special ventilation and 6 for comparison of special ventilation and half-stage and full-bunker initial icing. The designation and type of cars used in the tests, the kind of protective services, loading data, and other information are given in table 1.

On September 4 and 5, cars loaded with Red Pontiac potatoes were shipped under standard or special ventilation from Johnstown, N. Dak. to Goulds, Fla. On September 10 and 12, cars loaded with Triumph potatoes were shipped under special ventilation, half-stage initial icing, or full-bunker initial icing from Grafton, N. Dak. to Fort Myers, Fla.

Test Cars

All test cars except C and D were standard end-bunker cars in fair to good condition and had sidewall flues and Preco fans under the floor racks. The fans were sealed in the off position in cars H, I, and J. Prior to loading the floor racks of all cars except C and D were covered with 12- x 30-inch fabricated pads filled with macerated paper.

Loading

The cars were loaded with the "40,000 pound pyramid through load" as recommended by the Association of American Railroads. 2/

1/ The study was made under authority of the Agricultural Marketing Act of 1946 (RMA, Title II).

2/ Recommended arrangement for loading potatoes in 100-pound bags by the "Pyramid through load" method, 36,000 and 40,000-pound load. Association of American Railroads General Information Series No. 519. 1953.

An additional 300 pounds of test potatoes was placed in each car shipped from Johnstown and an additional 600 pounds in each car shipped from Grafton.

Inspection

Randomly selected 100-tuber samples from each test sack were examined before loading, upon arrival in Florida, and after 1 week in Florida. Data were taken on the amount of mechanical injury, decay, external brown discoloration, sunscald, and skinning.

Commodity and Air Temperatures

Ryan thermometers recorded the temperatures at the outside doorway of one car of each day's shipment and next to the top bunker opening into the loading space in one end of each car having open vents. Ryan recording thermometers were placed in the center of a 100-pound sack of potatoes placed in the top, middle, and bottom layers along the center-line of the load in the rear-quarter-length of the car.

The air temperatures recorded by the Ryan thermometers within the sacks approximated so closely the temperature of the potatoes that they are referred to as "potato temperatures" in this report. To supplement the data from the recording thermometer, temperatures of the potatoes were obtained with hand thermometers while the test packages were being prepared for loading and during unloading. Temperatures from the thermograph tapes plotted at 4-hour intervals are presented in figures 1 to 7.

Manipulation of Vents

Temperatures of the potatoes and of the outside air and the air in the top bunkers and the period of time when the vents were open or closed are shown for all test cars in figures 1 to 7. Special-ventilation service consisted of having the vents open at night and closed during the day. Except in certain cases, vents on cars moving under special-ventilation service were manipulated at regular railroad inspection points in accordance with instructions on the waybill. The vents were not manipulated between Daytons Bluff, Minn., and Chicago, Ill., on cars B and D the evenings of September 6 and 7 respectively, as no regular inspection stations were passed. Also, the vents were not manipulated between Montgomery, Ala., and New Smyrna Beach, Fla., on cars B and D the evenings of September 9 and 10, respectively, as the regular inspection station at Jacksonville, Fla., was reached in the middle of the night and the next inspection station was not scheduled to be reached until the next evening. It appears, however, from the data in figures 1 to 3 that practically no change in commodity temperature would have been brought about if the vents had been open during these nights. The places and times of opening and closing the vents in cars B, D, E, and H are given in table 2.

RESULTS

Standard Ventilation vs. Special Ventilation

Fan Cars with Fans On.--During loading, the air and mean potato temperatures were about 56° F. The potato temperatures changed very little until warm weather was encountered during the latter part of the transit period. During the last 3 days the air temperature at the bunker opening in the standard-ventilation car A was mostly about 70° with wide fluctuations between day and night. In the special-ventilation car B the air temperature at the bunker opening at this time was mostly between 60° and 70° with relatively narrow fluctuations between day and night.

Mean potato temperatures, as shown in figure 1, were about the same in cars A and B until warm weather was encountered. Then the temperature of the potatoes rose in both cars but at a more rapid rate in the standard-ventilation car A.

At the time of unloading, the mean potato temperature in the special ventilation car B was about 63°F. as compared with 72° in the standard-ventilation car A, a difference of 9°. None of the potato temperatures during transit in either car were excessively high (figs. 1 and 2).

The test with these two cars indicates that when warm weather is encountered in transit, the potatoes in fan cars may remain cool longer when moving under special-ventilation service than when moving under standard-ventilation service.

Non-Fan Cars.--During loading, the air temperatures were 55° and 62° F. and the mean potato temperatures were 51° and 56° in cars D and C, respectively, as given by hand-thermometer readings (table 1). Warm weather the last 3 days in transit resulted in higher air temperatures in the bunker opening in car C moving under standard ventilation than in car D under special ventilation-- both cars without fans. The temperatures of the potatoes in both cars, however, were almost the same throughout the transit period (fig. 3). Only potato temperatures at the top-quarter-length position in cars C and D are shown since they were the warmest and the pattern was the same as in the other positions.

Special-ventilation service was no better in these two non-fan cars than standard ventilation service in holding potatoes at a desirable temperature when outside temperatures were high.

Special Ventilation vs. Half-Stage and Full-Bunker Initial Icing

Fan Cars with Fans On.--Special-ventilation service was compared with half-stage initial icing and full-bunker initial icing in cars E, F, and G (fig. 4).

During loading, hand-thermometer readings of air temperatures were 71°, 79°, and 79° F. and mean potato temperatures were 64°, 76°, and 73° in

cars E, F, and G, respectively (table 1). In transit, outside air temperatures during the day usually were in the seventies or eighties and generally dropped to the fifties or sixties during the night.

The potato temperatures in car E shipped under special-ventilation service, and in car G, shipped under half-stage initial icing service, were mostly between 55° and 65° F. In car F, however, moving under full-bunker initial icing service, potato temperatures were above 60° the first 2 days and then ranged in the forties and fifties for the next 7 days. This may have been sufficiently low to prolong dormancy or delay periderm formation in wounds. In these tests, the potatoes moving under special-ventilation service were warmer than those having full-bunker initial icing service and were about as warm as those having half-stage initial icing service. None of the potato temperatures were high enough to favor development of soft rot.

Fan Cars with Fans Off.--Air temperatures and mean potato temperatures as taken with hand thermometers during loading ranged from 61° to 70° F. The air temperature at the bunker opening rose above 70° in the special-ventilation car H on the sixth day in transit and the outside air temperature reached a maximum of 100° on the seventh and eighth days (figs. 5, 6, and 7). The potato temperature in this car ranged from 55° early in the transit period in the bottom layer (fig. 5) to 74° in the top layer late in the transit period (fig. 6).

The potato temperature in the bottom layer of car J, moving under full-bunker initial icing service, dropped rapidly after icing from 71° to 50° F. in about 24 hours and remained below 50° for approximately 6 days with a minimum of 42° on the fifth day (fig. 5). Car I, moving under half-stage initial icing, also had temperatures in the bottom layer below 50° but for only 3 days and the minimum was only 47°.

Top-layer potatoes in transit in the half-stage iced car I and in the full-bunker iced car J cooled rapidly at about the same rate after icing. The potatoes in the special-ventilation car H were cool when shipped and remained near the same temperature until the seventh day. On encountering hot weather the potatoes in the special-ventilation car H and in the half-stage iced car I warmed at about the same rate and more rapidly than in the full-bunker iced car J. With the outside temperatures encountered in this test, special ventilation provided just as satisfactory transit temperatures as half-stage icing and was more economical.

The mean temperatures of the potatoes at the quarter-length position in these 3 cars were not too low or too high, as shown in figure 7. Special ventilation gave perhaps the most suitable temperatures for healing wounds and probably prolonged the dormant period of the potatoes less than did refrigeration.

Decay

The potatoes in all test cars were damp or wet when unloaded but practically no decay was found in the samples examined. The reason probably was that the

transit temperatures were too low most of the time for the rapid development of bacterial soft rot, the most serious transit disease of potatoes. A few tubers with small areas affected with fusarium rot were found. In most tubers these rots dried-up during the first week in Florida.

There was no correlation between the amount of fusarium rot present after holding 1 week in Florida and the type of protective service the potatoes received in transit.

SUMMARY

Ten test cars of North Dakota-grown seed potatoes were shipped to Florida in September 1953 under four types of protective service. The potatoes were dug and shipped during cool weather and encountered warm temperatures only on the last few days in transit.

In these tests, potatoes in fan cars stayed cool longer under special-ventilation service (vents open at night and closed during the day) than under standard-ventilation service. In non-fan cars, however, special-ventilation service was no better than standard ventilation.

Special-ventilation service gave more suitable temperatures for healing wounds and probably prolonged the dormant period of the potatoes less than full-bunker initial icing service. Special-ventilation service was just as satisfactory and more economical than half-stage initial icing service in cars with and without fans.

Bacterial soft rot did not develop in the potatoes in any of these test shipments.

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Table 1.--Data on the test cars, protective services, loading, and routing, September 1953

Car Designation	Car Type	Type of protective services compared	Load				Mean Temperature During Loading		Routing
			Weight 1/	Date	Start	Finish	Air	Potato	
			Pounds				°F.	°F.	
A(MDT10872)	Fan	Standard Ventilation	40,300	9-3-53	7:00am	8:15am	56	55	NP, CB&Q.
		vs.							
B(MDT9640)	Fan	Special Ventilation 2/	40,300	9-3-53	8:30am	9:15am	58	56	C&EI L&N,
C(NP90582)	Non-fan	Standard Ventilation	40,300	9-4-53	1:00pm	2:00pm	62	56	SAL, and
		vs.							
D(NP90794)	Non-fan	Special Ventilation 2/	40,300	9-4-53	10:00am	11:00am	55	51	FEC
E(WFE69274)	Fan	Special Ventilation 2/	40,600	9-9-53	10:35am	2:00pm	71	64	
		vs.							
F(WFE68833)	Fan	Full-bunker Initial Icing	40,600	9-9-53	2:15pm	5:30pm	79	76	GN, CB&Q,
		vs.							
G(WFE68657)	Fan	Half-stage Initial Icing	40,600	9-9-53	5:35pm	8:10pm	79	73	NC&STL, and
H(FGE39516)	Fan 3/	Special Ventilation 2/	40,600	9-11-53	9:55am	1:15pm	69	62	ACL
		vs.							
I(FGE39500)	Fan 3/	Half-stage Initial Icing	40,600	9-11-53	7:30am	9:50am	65	61	
		vs.							
J(FGE39318)	Fan 3/	Full-bunker Initial Icing	40,600	9-10-53	8:00am	8:00pm	70	70	

1/ All cars loaded with potatoes in 100-pound burlap bags.
2/ Vents kept open at night and closed during the day.
3/ Fans sealed in off position.

Table 2.--Time and place of vent manipulation on cars moving under special-ventilation service

Car designation and date	Time vents Open P.m.	Time vents Closed A.m.	Place at which vents were manipulated
Car B (MDT9640):			
Sept. 3.....	5:40	---	Johnstown, N. Dak.
" 4.....	---	8:00	Johnstown, N. Dak.
" 4.....	4:30	---	East Grand Forks, Minn.
" 5.....	---	6:00	Staples, Minn.
" 5.....	7:30	---	Northtown, Minn.
" 6.....	---	5:30	Daytons Bluff, Minn.
" 6.....	---	---	- - -
" 7.....	---	---	- - -
" 7.....	6:30	---	Chicago, Ill.
" 8.....	---	5:25	Evansville, Ind.
" 8.....	3:30	---	Nashville, Tenn.
" 9.....	---	3:25	Montgomery, Ala.
" 9.....	---	---	- -
" 10.....	---	12:05	Jacksonville, Fla.
" 10.....	4:25	---	New Smyrna Beach, Fla.
" 11.....	---	12:30	Miami, Fla.
Car D(NP90794):			
Sept. 4.....	5:00	---	Johnstown, N. Dak.
" 5.....	---	7:30	Johnstown, N. Dak.
" 5.....	4:30	---	East Grand Forks, Minn.
" 6.....	---	6:00	Staples, Minn.
" 6.....	6:00	---	Northtown, Minn.
" 7.....	---	6:45	Daytons Bluff, Minn.
" 7.....	---	---	- - -
" 8.....	---	---	- - -
" 8.....	6:30	---	Chicago, Ill.
" 9.....	---	7:25	Evansville, Ind.
" 9.....	4:30	---	Nashville, Tenn.
" 10.....	---	4:16	Montgomery, Ala.
" 10.....	---	---	- -
" 11.....	---	12:01	Jacksonville, Fla.
" 11.....	4:55	---	New Smyrna Beach, Fla.
" 12.....	---	1:00	Miami, Fla.
Car E(WFE69274):			
Sept. 10.....	---	8:00	Grafton, N. Dak.
" 10.....	6:00	---	Grand Forks, N. Dak.
" 11.....	---	6:00	Grand Forks, N. Dak.
" 11.....	4:10	---	Fargo, N. Dak.
" 12.....	---	7:30	Minneapolis, Minn.
" 12.....	7:00	---	Daytons Bluff, Minn.
" 13.....	---	1:20	Galesburg, Ill.
" 13.....	6:30	---	Galesburg, Ill.
" 14.....	---	3:20	Galesburg, Ill.
" 14.....	8:10	---	Paducah, Ky.
" 15.....	---	5:45	Nashville, Tenn.
" 15.....	6:10	---	Atlanta, Ga.
" 16.....	---	9:00	Fitzgerald, Ga.
" 16.....	3:52	---	Waycross, Ga.
" 17.....	---	6:00	Trilby, Fla.
" 17.....	12:00N	---	Lakeland, Fla.
Car H(FGE39516):			
Sept. 11.....	---	10:00	Grafton, N. Dak.
" 11.....	7:00	---	Grafton, N. Dak.
" 12.....	---	10:00	Grafton, N. Dak.
" 12.....	7:00	---	Grand Forks, N. Dak.
" 13.....	---	6:00	Grand Forks, N. Dak.
" 13.....	8:00	---	Fargo, N. Dak.
" 14.....	---	6:30	Minneapolis, Minn.
" 14.....	7:25	---	Daytons Bluff, Minn.
" 15.....	---	6:30	Savanna, Ill.
" 15.....	6:30	---	Galesburg, Ill.
" 16.....	---	5:30	Galesburg, Ill.
" 16.....	3:22	---	Centralia, Ill.
" 17.....	---	6:50	Nashville, Tenn.
" 17.....	6:35	---	Atlanta, Ga.
" 18.....	---	11:45	Fitzgerald, Ga.
" 18.....	6:50	---	Waycross, Ga.
" 19.....	---	6:00	Trilby, Fla.
" 19.....	11:00	---	Lakeland, Fla.

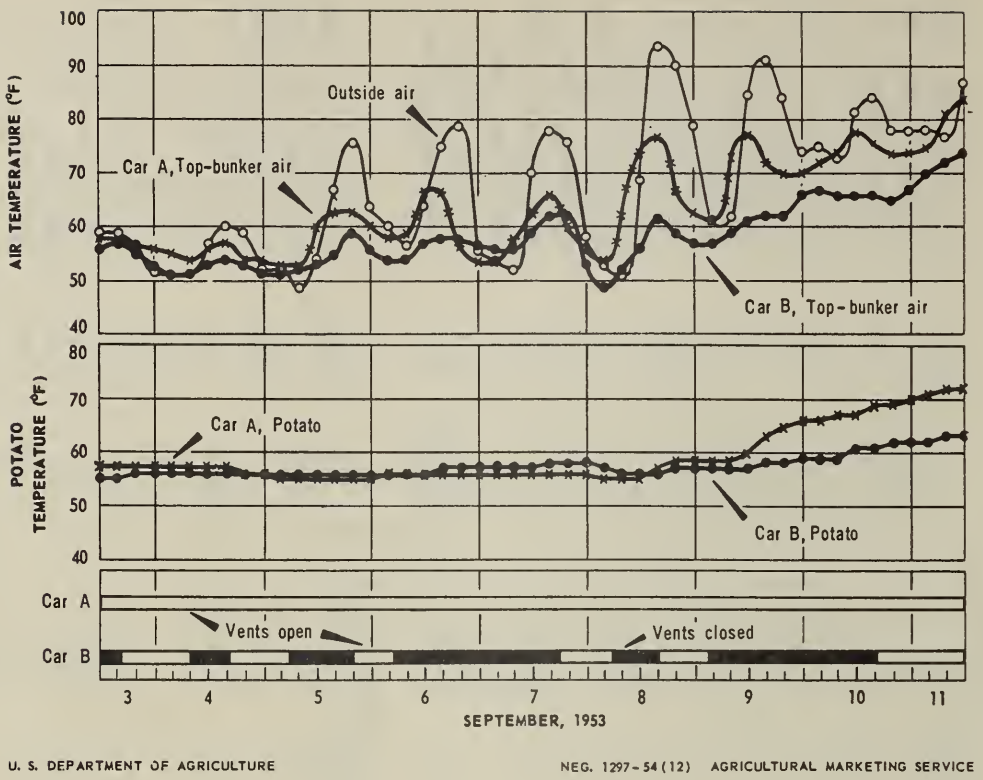

Figure 1.--Mean quarter-length center-line potato, outside air and top bunker-opening air temperatures and vent positions in transit. Fan cars. Car A--standard ventilation. Car B--special ventilation.

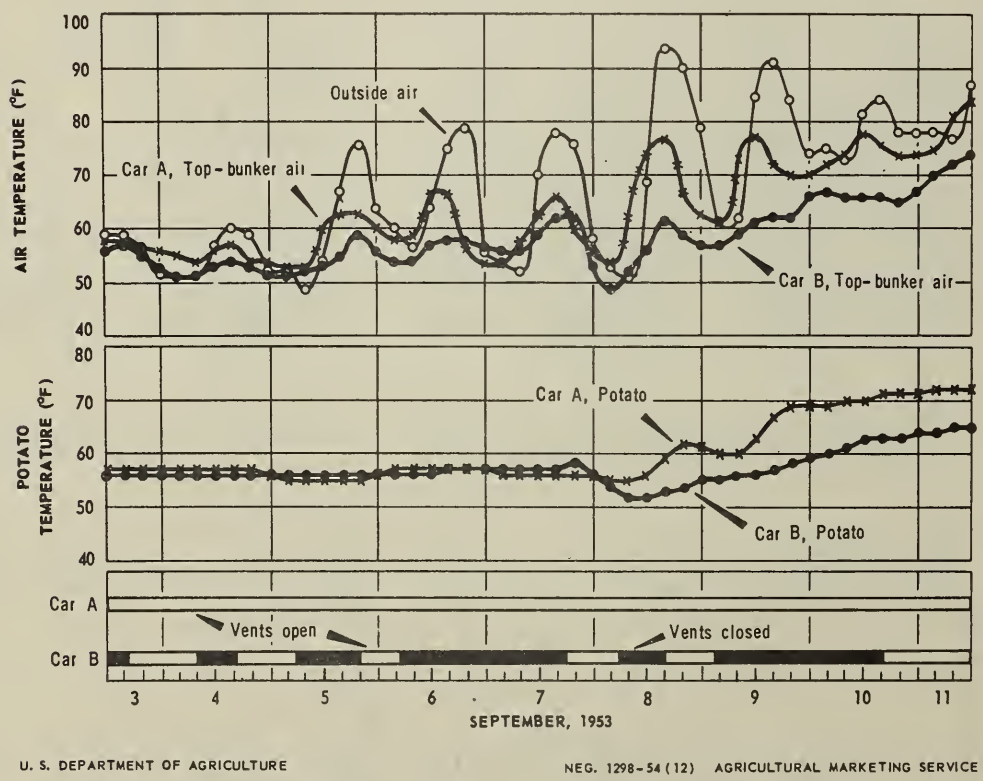

Figure 2.--Top quarter-length center-line potato, outside air, and top bunker-opening air temperatures and vent positions in transit. Fan cars. Car A--standard ventilation. Car B--special ventilation.

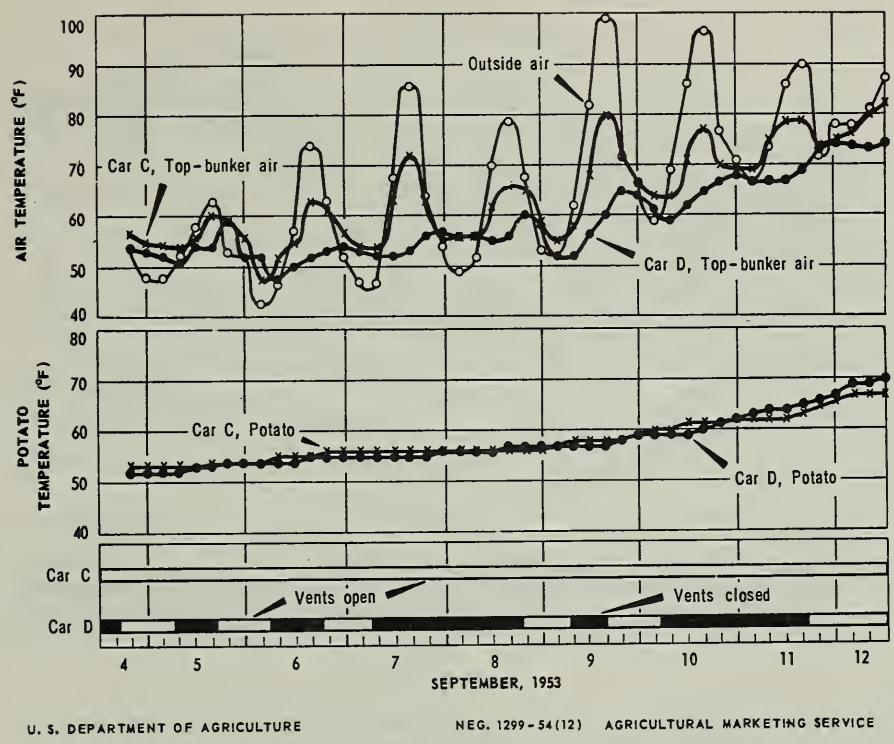

Figure 3.--Top quarter-length center-line potato, outside air, and top bunker-opening air temperatures and vent positions in transit. Non-fan cars. Car C--standard ventilation. Car D--special ventilation.

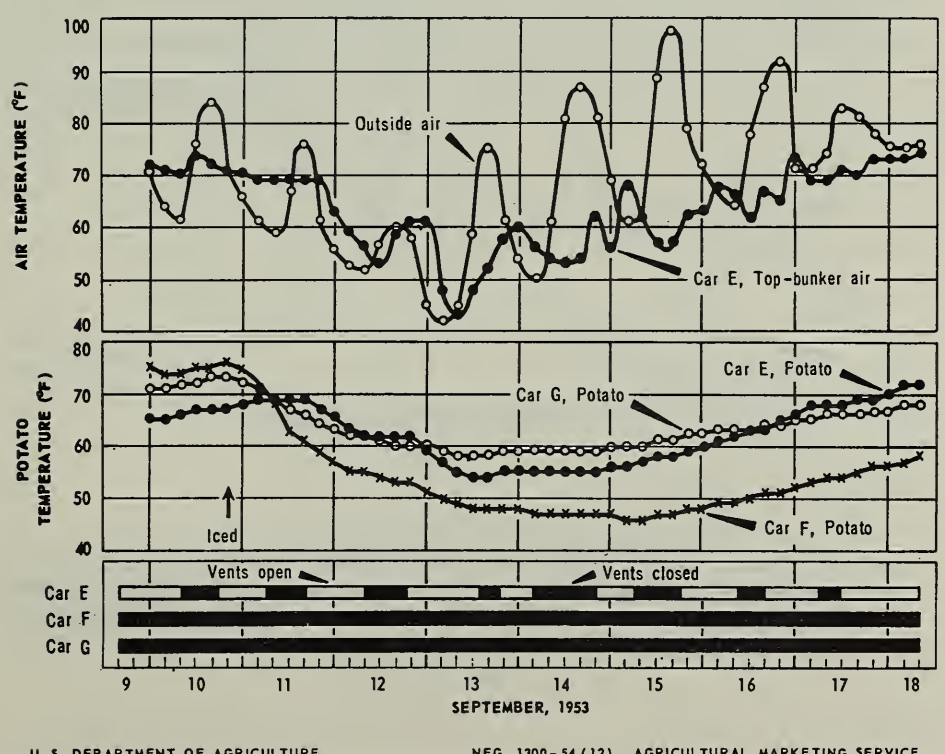

Figure 4.--Mean quarter-length center-line potato, outside air, and top bunker-opening air temperatures and vent positions in transit. Fan cars. Car E--special ventilation. Car F--full bunker initial icing. Car G--half-stage initial icing.

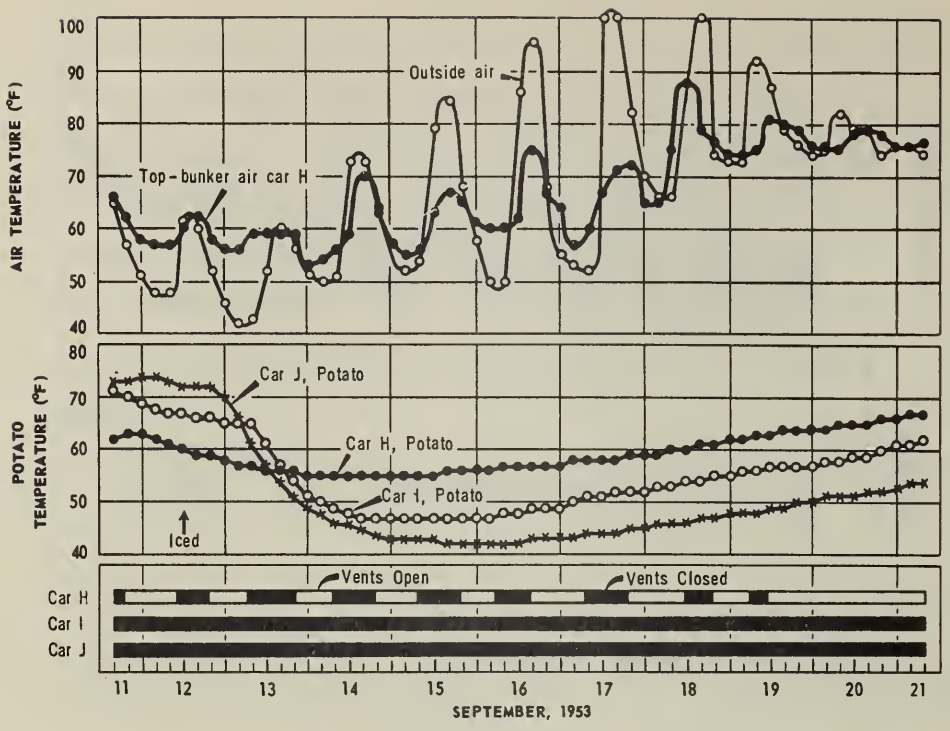

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Figure 5.--Bottom quarter-length center-line potato, outside air, and top bunker-opening air temperatures and vent positions in transit. Non-fan cars. Car H--special ventilation. Car I--half-stage initial icing. Car J--full bunker initial icing.

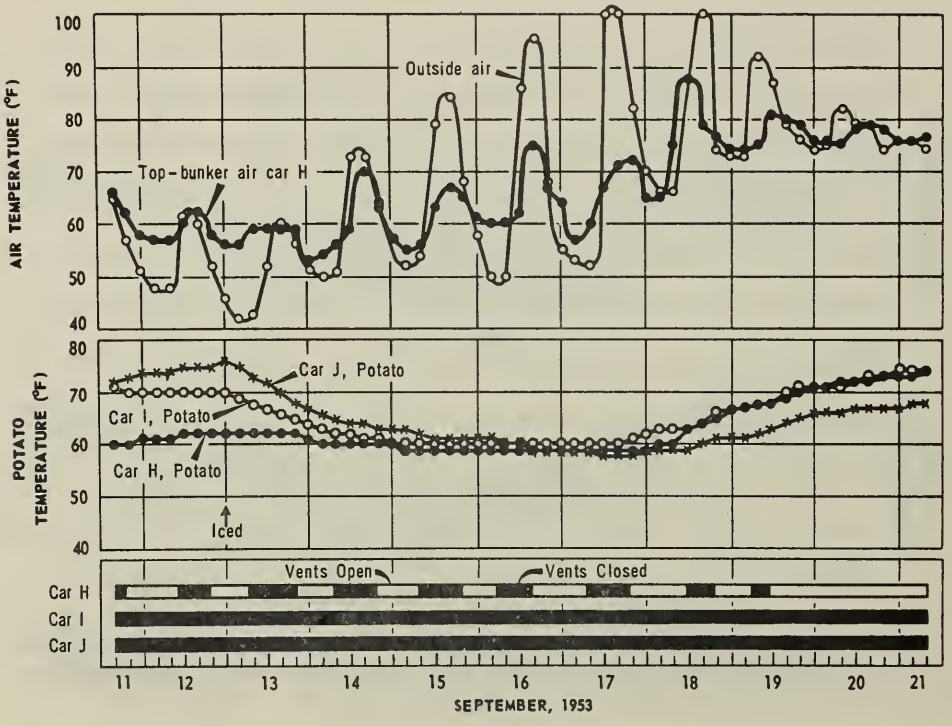

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Figure 6.--Top quarter-length center-line potato, outside air, and top bunker-opening air temperatures and vent positions in transit. Non-fan cars. Car H--special ventilation. Car I--half-stage initial icing. Car J--Full bunker initial icing.

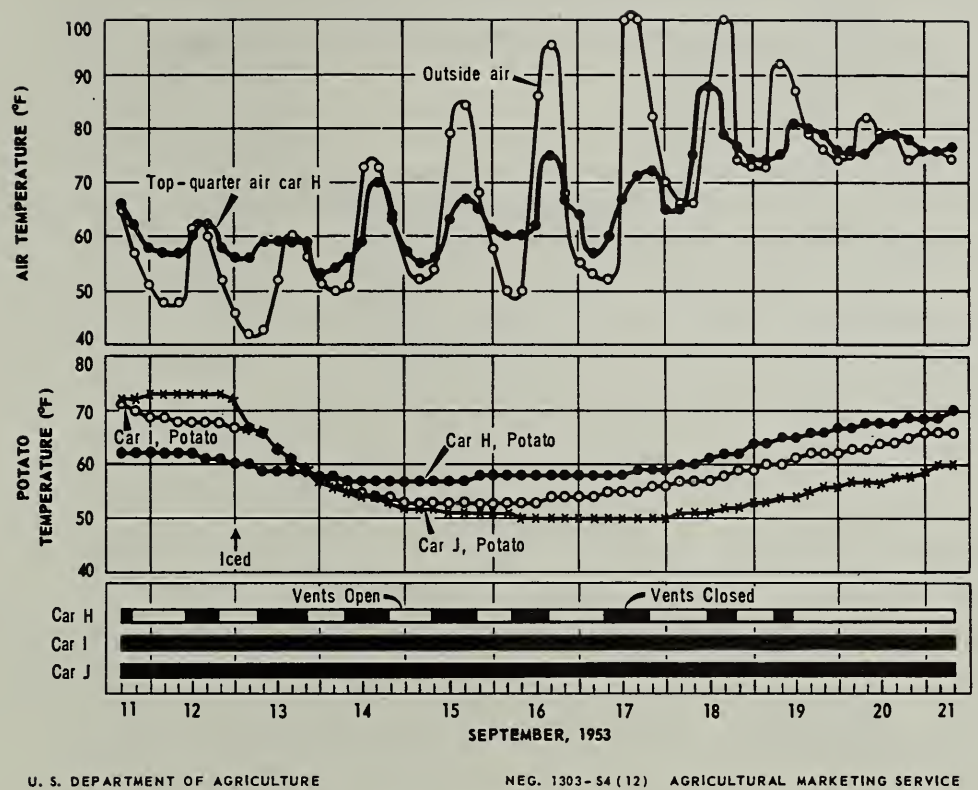

Figure 7.--Mean quarter-length center-line potato, outside air, and top bunker-opening air temperatures and vent positions in transit. Non-fan cars. Car H--special ventilation. Car I--half-stage initial icing. Car J--full-bunker initial icing.